

STRESS ANALYSIS OF THE WELDS IN THE GIRDER

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Introduction:

The girder at the back of each module plays an important structural role in the assembly of the Tilecalorimeter barrel. It is important, therefore, to clearly understand the welds within the girder. In order to understand the stresses in the welds, a 2-dimensional finite element model has been constructed of the girder cross section similar to the model that has been previously used by J. Blocki to analyze the girder. This model is shown in Fig. 1. Plain strain elements were used that had a thickness of 1mm.

Analysis:

In order to verify this model, it was initially run using the same force and boundary conditions as J. Blocki's model. The forces acting on the girder that have been supplied from J. Blocki's earlier analysis have been applied to this model, see Fig. 2, and similar results obtained, 200N/mm^2 max stress in the welds.

Since 200N/mm^2 is approaching the yield stress of 235N/mm^2 , it is important to reduce this maximum weld stress. In order to reduce the stresses in the weld, an additional bar was added to the model as shown in Fig. 6 and the FEA model in Fig. 3. Plain stress elements were used to model this additional bar. This bar had a width of 12mm and a thickness that was .04mm. The maximum stress occurred in the welds between the bar and the girder and were 153N/mm^2 , see Fig. 4. The thickness of the bar was then increased to 1mm and the stress in the weld was reduced to 138N/mm^2 , see Fig. 5. A bar of this thickness in the girder would be approximately 30mm wide in Z at every submodule.

The use of this bar would be a cheap and simple way to significantly reduce the weld stresses in the girder. The fiber routing scheme and the bolt pattern in the girder need to be examined in order to understand the affect of this bar and to optimize its thickness.

Conclusions:

The current European welding norms do not require stress concentrations within welds to be considered except under fatigue loading conditions. Since this is not the case for our design, the use of the average stress in sizing the welds is allowed under the European welding norms. An analysis of the welds by V. Romanov that only considered the average stress, showed that the average weld stress was 38N/mm^2 , well within acceptable limits. However, it should be kept in mind that the forces on the welds vary significantly along the length of the girder so the average stress may not be an adequate method of analyzing these welds. In addition, since these welds are so critical to the structural integrity of the Tilecalorimeter, it is desirable to examine stress concentrations even though this is not required by the European norms. Therefore, it is recommended that a 30mm wide bar as shown in Fig. 3 be used on the ten modules that see the highest load from the cryostat. This is a very simple and low-cost modification to a small number of girders that will provide significant additional safety.

An additional modification that should be made to the girder concerns the type of welds that are used. According to the European norms, the fillet welds that are shown in the current girder design are not allowed, but recommend penetration butt welds. The design of the girder should be updated to reflect this recommendation.

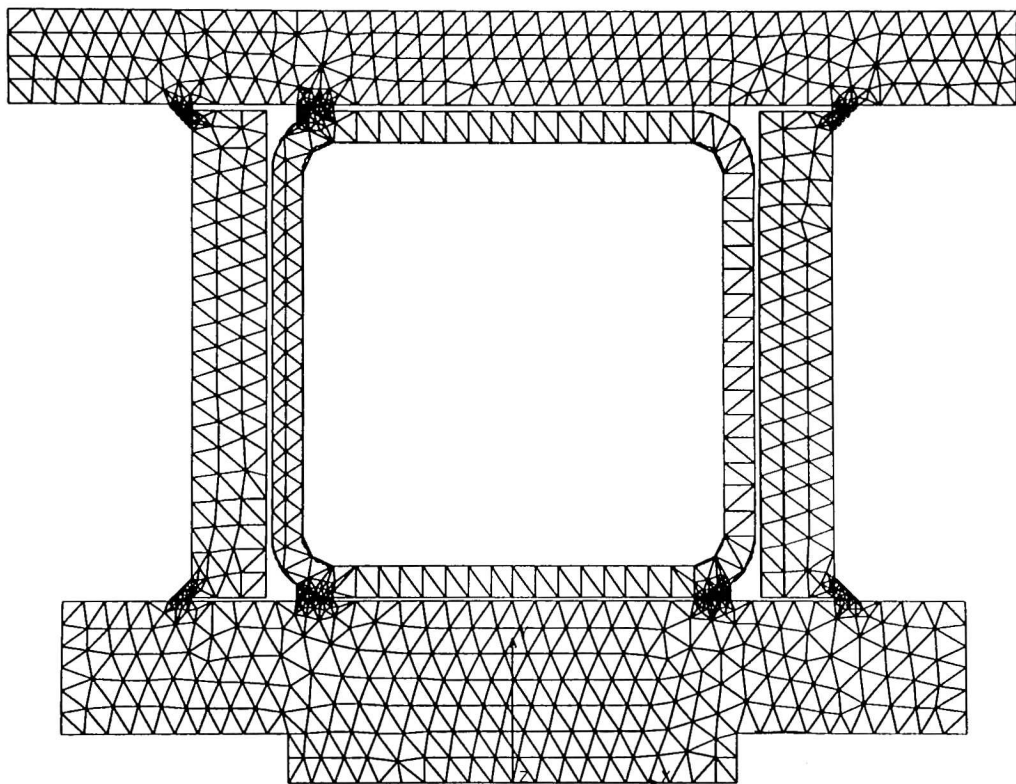
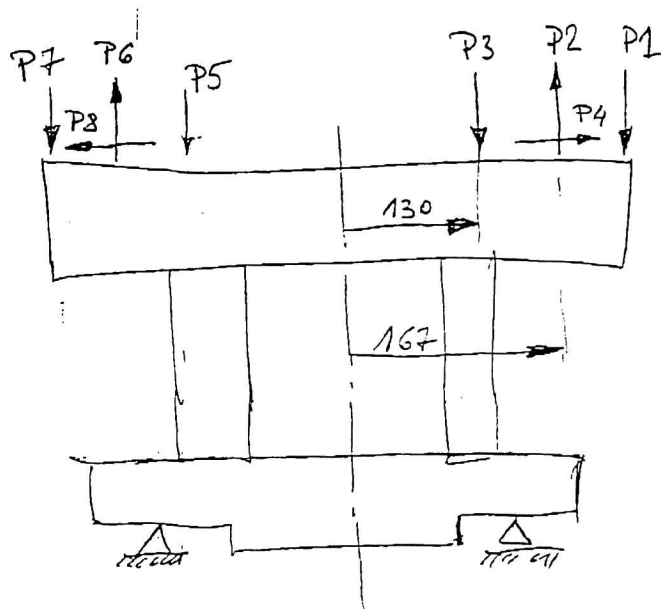


Figure 1. FEA model similar to that of J. Blocki.



No. module	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8
23	256	-27.7	0	-235.3	313.0	523.2	0	-190.0
22	295	-33.1	0	-190.0	353.0	608.3	0	-138.3
21	334	-19.9	0	-138.3	286.0	567.3	0	-83.4
20	334	59.7	0	-83.4	209.0	410.0	0	-36.3
19	239	40.2	0	-36.3	146.0	272.8	0	0

P_1, \dots, P_8 in N/mm

Figure 2. Forces on girder provided by J. Blocki.

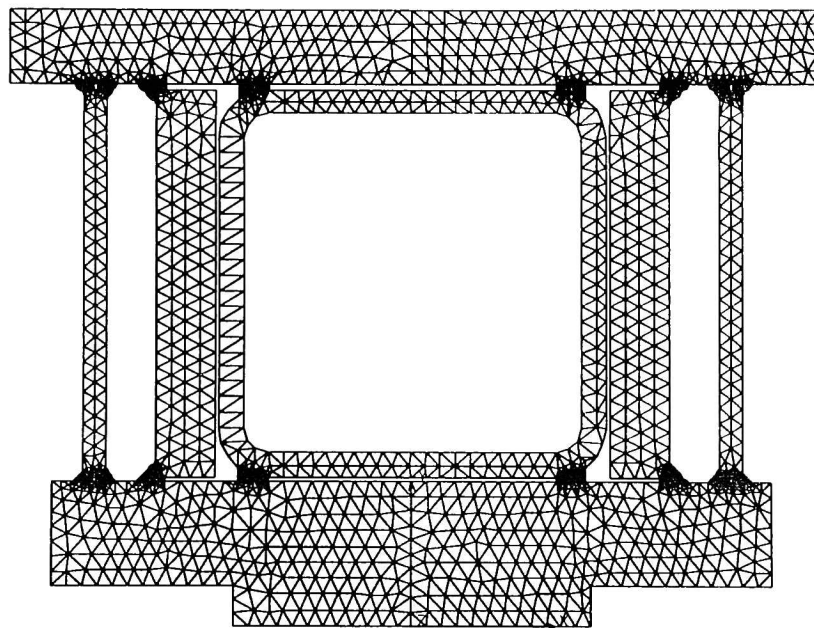


Figure 3. FEA model of proposed design.

Lin STRESS Lc=1

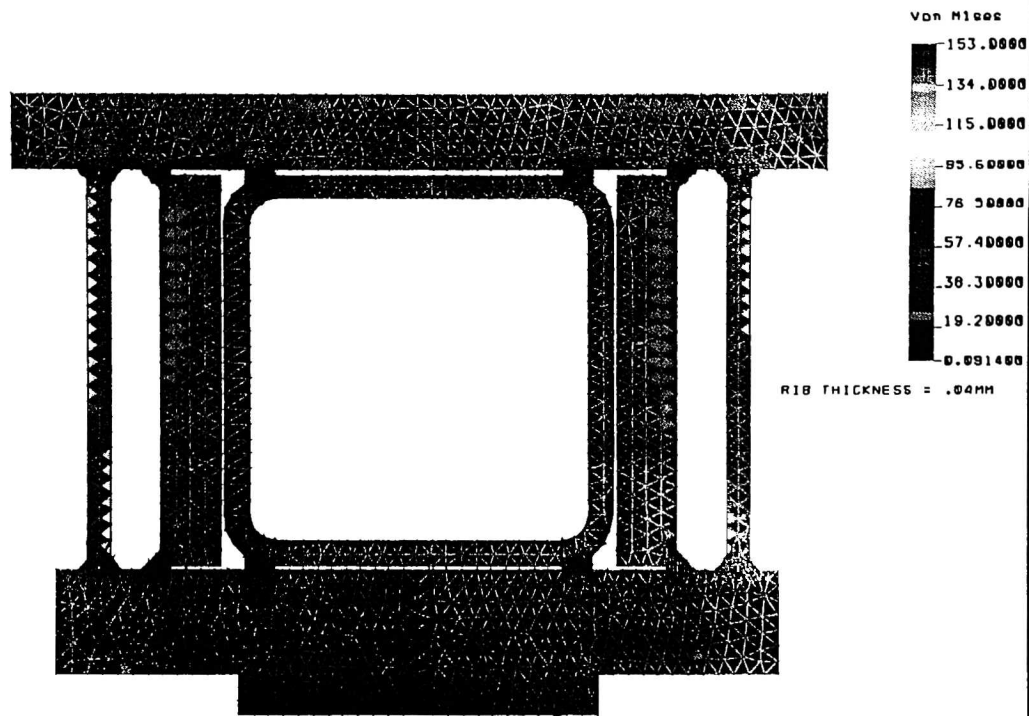


Figure 4. Stress plot of proposed design: Rib thickness = .04mm.

L1n STRESS Lc=1

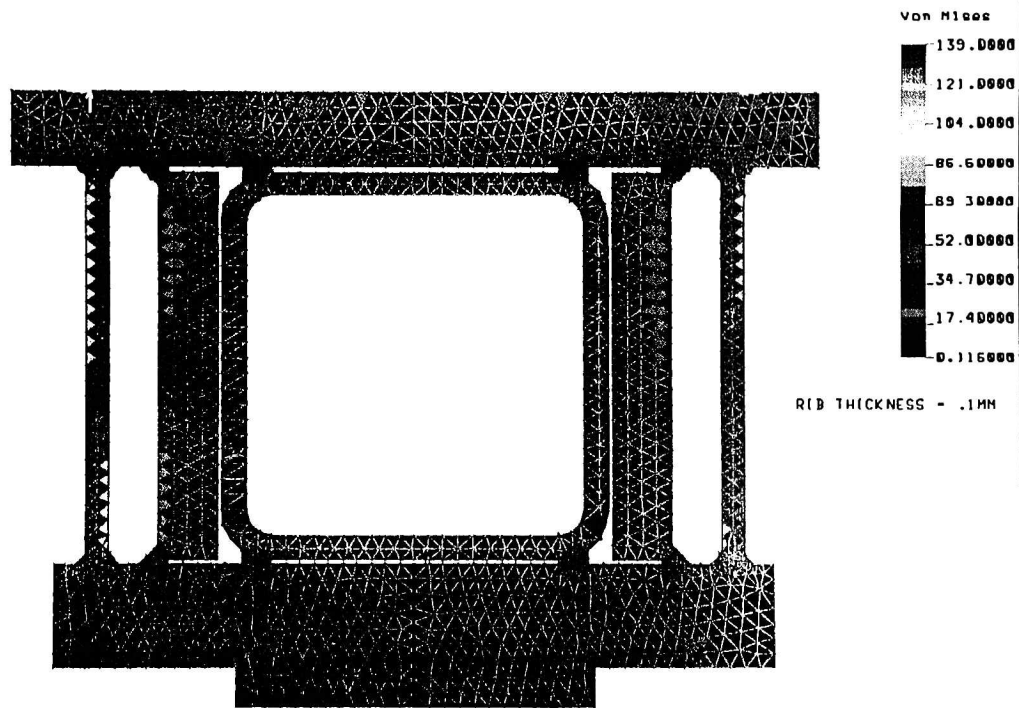
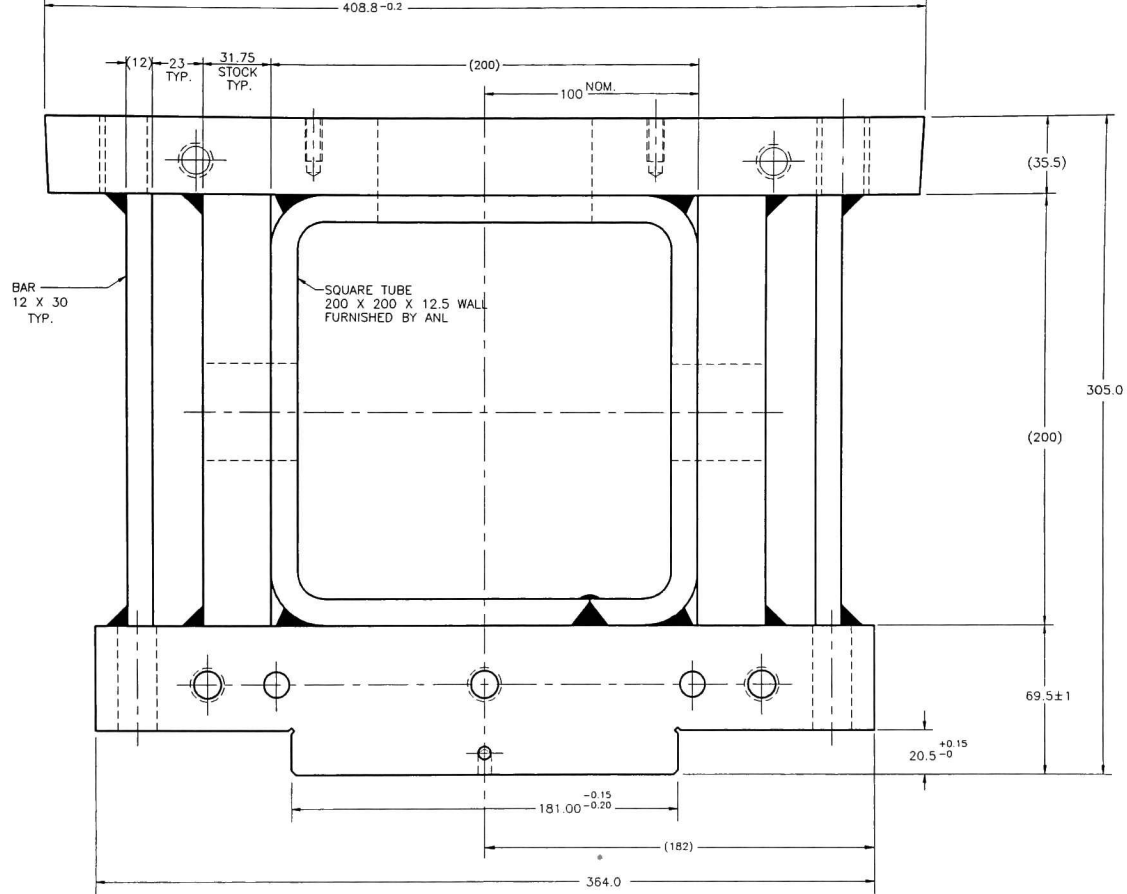


Figure 5. Stress plot of proposed design: Rib thickness = .1mm.



DIMENSIONS ARE IN mm.

PROPOSED GIRDER DESIGN

Figure 6. Schematic of proposed girder design.

3 4444 00034636 1



100 μ m



100 μ m